



Blue Origin

Blue Origin, LLC

Response to NASA Request For Information

COMMERCIAL REUSABLE SUBORBITAL RESEARCH PROGRAM - CRuSR

February 16, 2010

Presented to
Commercial Reusable Suborbital Research Program (CRuSR) Office
NASA
Solicitation Number: NNA10CR001L
Initial Release: December 4, 2009
Modification 2: February 5, 2010
Classification Code: A -- Research and Development



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Commercial Reusable Suborbital Research Program (CRuSR) Office

Re: Response to NASA Request For Information (RFI):

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Blue Origin is pleased to offer the following response to modification 2 of the above-referenced RFI:

BACKGROUND ON NEW SHEPARD PROGRAM

Blue Origin is developing the *New Shepard* reusable launch vehicle (RLV). The *New Shepard* RLV will launch vertically, ascend to suborbital altitudes to carry both people and experiments to space, then perform a powered vertical landing for recovery and reuse of the vehicle.

The *New Shepard* system will be comprised of a Propulsion Module and a Crew Capsule. The Crew Capsule will be stacked on top of the Propulsion Module, and will be capable of separating from the Propulsion Module during flight.

Both the Propulsion Module and Crew Capsule will be fully reusable, carry their own avionics, and operate autonomously under the control of on-board computers. The Propulsion Module will use 90 percent concentration hydrogen peroxide as oxidizer and rocket propellant grade kerosene (RP) as propellant. The Crew Capsule will carry a solid rocket motor for use in an emergency escape situation. The Crew Capsule will have a low-thrust reaction control system (RCS) using cold gas for orientation.

Blue Origin is developing a standard Cabin Payload System (CPS) to host experiments inside the Crew Capsule. Each CPS rack will be divided into standard modular Cabin Payload Bays (CPBs).

A. Flight Operations Information

(1) Planned start of commercial operations for payloads or space flight participants

Blue Origin is currently working with several universities on a Phase 1 Research Flight Demonstration Program. The purpose of this program is to serve as a pathfinder, demonstrating the integration and operation of scientific experiments during unmanned test flights of the *New Shepard* system to high altitudes. The selected experiments are:

- *Three-Dimensional Critical Wetting Experiment in Microgravity*. The principal investigator of this effort is Dr. Steven Collicott, of Purdue University.
- *Microgravity Experiment on Dust Environments in Astrophysics (MEDEA)*. The principal investigator of this effort is Dr. Joshua Colwell, of the University of Central Florida. The Southwest Research Institute is also contributing to this experiment.
- *Effective Interfacial Tension Induced Convection (EITIC)*. The principal investigator of this effort is Dr. John Pojman, of Louisiana State University. Professor Patrick Bunton of William Jewell College is also contributing to this experiment.

Standard payload interfaces, accommodations, and services are being developed as part of this program. These experiment test flights might occur as early as 2011. Commercial operations with unmanned research payloads might begin as early as 2011-2012. Blue Origin has not yet set the date to begin commercial operations with on-board technicians and astronauts.

(2) How many space flight participant or payload spaces per flight

Blue Origin anticipates space for 3 or more astronauts or Cabin Payload System (CPS) racks, or some combination of astronauts and CPS racks, aboard the *New Shepard* vehicle.

(3) Planned frequency of flights

The flight rate would depend on market demand, but Blue Origin anticipates rates up to approximately 52 launches per year of the *New Shepard* vehicle.

(4) Location(s) of launch and landing

The *New Shepard* flight program will be conducted from Blue Origin's West Texas Launch Site (WTLS). WTLS is located in the remote desert of Culberson County, North of Van Horn, Texas, about a two hour drive from the El Paso airport. Launches and landings will both take place at Blue Origin's WTLS facility.

(5) Typical flight duration

The *New Shepard* launch, flight, and landing activities will require approximately a 10 minute period to complete.

(6) Maximum flight altitude

After a propulsive boost phase, the *New Shepard* vehicle will coast up to an apogee greater than 325,000 feet (over 100,000 meters), then return to the launch site. The entire flight will be nearly vertical.

B. Payload Information**(1) Volume/dimensions available**

Blue Origin is developing a standard Cabin Payload System (CPS) to host experiments inside the *New Shepard* Crew Capsule. Each CPS rack is planned to support a total of up to approximately 10.6 cubic feet (over 300 liters) of available volume for payloads, divided into standard modular Cabin Payload Bays (CPBs) with either approximately 1.8 cubic feet (over 50 liters) of payload volume, or a double-height CPB with a payload volume of approximately 3.6 cubic feet (over 100 liters).

(2) Mass available

Each standard CPB will accommodate approximately 25 lbs (11.3 kg) of payload and the double-height CPB will accommodate approximately 50 lbs (22.7 kg). Blue Origin will consider payloads that are larger than the standard bay sizes, particularly for experiments seeking a high flight rate. A rack provided by an outside organization should not exceed approximately 260 lbs (120 kg) of carry-on mass.

(3) Maximum vibration to design for

Vibration information will be made available to researchers at a later date.

(4) Maximum g-load to design for: (i) Take-off (ii) Flight (iii) Landing (iv) Taxi

A *New Shepard* flight might experience maximum sustained g loads of up to 6 g, with up to a 10 g transient on landing, on a nominal mission.

(5) Normal operating pressure and temperature

The Crew Capsule's cabin will be pressurized and have systems for maintaining temperature, humidity, and oxygen and carbon dioxide partial pressures. Cabin pressure will be maintained between approximately 11 – 14 psia, and the atmosphere will be maintained at a comfortable level for crew habitation.

(6) Payload access before and after flight

Researchers will prepare CPBs at the researcher's facility, and bring them to the launch site for flight. Facilities will be available to the researcher at the launch site for final configuration of the experiment. The researcher will deliver the experiment in the CPB(s) for insertion into the *New Shepard* vehicle. If the experiment has telemetry, data consoles will be available to researchers on the ground to monitor payload data during pre-flight, flight, and post-flight operations. Shortly after the flight, researchers will be able to access the experiment's on-board data storage and the experiment hardware itself.

(7) Typical duration of microgravity

Blue Origin anticipates that the Crew Capsule will experience 3 or more minutes of microgravity at a level less than 0.001 g during a typical flight.

(8) Access to environment external to the vehicle (e.g., open, optical through windows, sample ports)

The Crew Capsule will contain windows, allowing viewing of both Earth and space. Experiment racks could be positioned to optimize window access and field of view.

Blue Origin is exploring the possibility of supporting externally-mounted experiments, such as sensors that can sample the atmosphere. These experiments will likely be constrained not to violate the outer mold line of the vehicle.

The Crew Capsule has the capability to point to within +/- 5° of a commanded attitude hold position during the microgravity phase of flight and limit rates to less than 5°/second.

C. Space Flight Participant Information

Blue Origin has not yet developed detailed information concerning the astronaut crew. Initial demonstration research flights will not incorporate flight crew.

D. Special Capabilities

(1) *List other capabilities*

Each CPS rack will have a separate electronics bay provided by Blue Origin that can provide power, command and control, and data recording services to experiments. This electronics bay will have an embedded computer that can be programmed by researchers. Blue Origin plans to provide the following electrical interfaces and services to payloads using the CPS rack:

- 28V power
- Analog outputs
- Analog inputs
- Digital I/O
- RS-232
- Ethernet
- Video cameras
- 1 Mbps total telemetry bandwidth
- Over 250 GB of on-board data storage capacity

Additional information can be found at: <http://www.blueorigin.com/nsresearch.html>

Company Point of Contact to acquire additional information

Please contact Dr. Alan Stern, Blue Origin's independent representative for research mission applications, at astern@blueorigin.com, or at 303-324-5269.

Thank you for the opportunity to submit information concerning Blue Origin's *New Shepard* suborbital flight program.

ACRONYMS:

CPB	Cabin Payload Bay
CPS	Cabin Payload System
RCS	Reaction Control System
REM	Research and Education Mission
RLV	Reusable Launch Vehicle
RP	rocket propellant grade kerosene
WTLS	Blue Origin's privately-owned West Texas launch Site in Culberson County, Texas